Japanese Patent Application No. 2001-285205

Job No.: 0-00958-2
Ref.: JP2000-228685 AND JP2001-285205//PU020488 JP/MAP(DAVIDA)/ORDER NO. ART339
Translated from Japanese by the McElroy Translation Company
800-531-9977 customerservice@mcelroytranslation.comJob

REFAB: PU020488
COUNTRY: JAPAN
Corres. US/UK________________

(19) JAPANESE PATENT OFFICE (JP)	(12) KOKAI TOKUHYO PATENT GAZETTE (A)	(11) PATENT APPLICATION NO. 2001-285205
		(43) Publication Date October 12, 2001

(51) Int. Cl.^{7}:	Identification Codes:	FI		Theme Codes (Reference):
H 04 B 10/20				5C056
H 04 J 1/10		H 04 J 1/10	B	5C064
H 04 L 12/44		H 04 N 5/00		5K002
H 04 N 5/00		7/10		5K022
7/10		7/22	N	5K033
H 04 N 7/22		H 04 B 9/00		
		H 04 L 11/00	340	

5C056 FA03 FA05 GA20 HA01 HA04 HA13 HA14
5C064 BA01 BA07 BB05 BC11 BC14 BC20 BD01 BD07 BD13 EA02
5K002 DA09 FA01 GA01
5K022 AA03 AA11 AA21 AA31
5K033 AA01 AA02 BA02 BA15 CB08 DA15 DB17 DB19

Examination Request: Not filed No. of Claims: 10 OL (Total of 15 pages) (Continued on last page)

(21) Filing No.: 2000-99435
(22) Filing Date: March 31, 2000

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(Continued on last page)

(54) [Title] Transmission Method Using Optical Fiber Cable, Network System Using that Method, and Relay Device Thereof

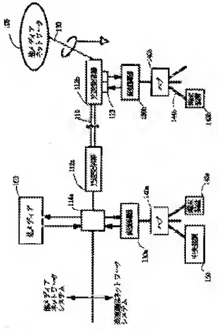
(57) Abstract

Problem

To implement a high-speed LAN with a network system that uses optical fiber cable and coaxial cable.

Means to solve

The upper limit frequency for a conventional other-media network is restricted by means of a coaxial cable 120, which is a branch line path. The nodes (112a, 112b) of this network system are provided with a multiplexer/demultiplexer 114a and a filter 113. Multiplexer/demultiplexer 114a multiplexes/demultiplexes a low-group signal of the other media and a high-group signal for use with a high-speed LAN. Filter 113 passes only the high-group data signal. Modems 130a, b and 140a, b are connected respectively to multiplexer/demultiplexer 114a and filter 113. A central device 150 and a terminal device 143b are capable of data communication at frequencies exceeding the upper limit frequencies of the other media in the respective directions [of said central device and terminal device]. Multi-channel [transmission] can be performed easily, so a high-speed LAN can be implemented.



[See end of document for translation of figure]

<u>Claims</u>

1. A transmission method for a network system for which an optical fiber cable or an optical fiber cable and a coaxial cable connected to that optical fiber cable are the transmission path,

the transmission method that uses an optical fiber cable being characterized in that a carrier wave of a prescribed frequency higher than an existing band in use is modulated with Ethernet specification data and is frequency-multiplexed together with the existing band in use, and an optical signal that has been intensity-modulated by means of said frequency-multiplexed signal is transmitted to the aforementioned optical fiber cable,

data communication being performed between terminal devices connected to the aforementioned optical fiber and/or the aforementioned coaxial cable or [being performed] with a terminal device and a central device.

2. The transmission method using an optical fiber cable and described in Claim 1, characterized in that the aforementioned data communication is performed by providing the aforementioned network system with a line concentration device that distributes/combines the aforementioned Ethernet specification data signal, and a modem that modulates/demodulates the aforementioned prescribed frequency carrier wave with said Ethernet specification data signal.

3. The transmission method using an optical fiber cable and recorded in Claim 1 or 2, characterized in that the modulation by the aforementioned modem is any one of amplitude modulation, frequency modulation, or phase modulation.

4. The transmission method using an optical fiber cable and described in any one of Claims 1-3, characterized in that the aforementioned data communication by means of an optical signal is performed by using the open time for a channel for the purpose of performing that data communication.

5. A relay device used in the transmission method using an optical fiber cable and described in any one of Claims 1-4,

the relay device of a transmission method that uses an optical fiber being characterized in that it is equipped with an optical transmitter-receiver that transmits and receives the aforementioned optical signal,

a modem that modulates the aforementioned data signal or demodulates to a data signal,

and a line concentration device that combines/distributes said data signal.

6. The network system that uses the transmission method using an optical fiber cable and described in any one of Claims 1-4,

being a network system that uses an optical fiber and that is characterized in that the aforementioned optical fiber cable is connected to a CATV station, and a TV signal and the aforementioned data signal are multiplexed in the downlink signal thereof.

7. The relay device used in the network system described in Claim 6, being a relay device of a network system that uses an optical fiber cable, characterized in that, in addition to the aforementioned optical transmitter-receiver and the aforementioned modem and the aforementioned line concentration device, it is equipped with a distributor that distributes a TV signal.

8. The network system that uses the transmission method using an optical fiber cable and described in any one of Claims 1-4,

being a network system that uses an optical fiber cable and is characterized in that the aforementioned network is a building network, and a terrestrial broadcast and/or satellite broadcast TV signal is frequency-multiplexed and transmitted on the aforementioned optical fiber cable from a broadcast reception device provided on said network.

9. The network system using an optical fiber cable and recorded in Claim 8, characterized in that the aforementioned building network is equipped with a line connection device having the aforementioned optical transmitter-receiver, the aforementioned modem, the aforementioned line concentration device, and the aforementioned distributor, and is connected to the aforementioned CATV network system by means of said line connection device.

10. The network system using an optical fiber cable and described in Claim 9, characterized in that the aforementioned line connection device is connected to the optical fiber cable of the aforementioned building network with an optical coupler, [thus] connecting the aforementioned building network system and the aforementioned CATV network system.

Detailed explanation of the invention

[0001]

Technical field of the invention

The present invention pertains to a transmission method that transmits data signals using optical fiber cable. Furthermore, it pertains to a network system that uses this transmission method and to a relay device installed in that system. In particular, it pertains to a method whereby Ethernet (registered trademark) specification data is frequency multiplexed and transmitted/received [using] optical fiber cable. The present invention can be applied to a local area network that is capable of high-speed communication between various terminals using optical fiber cable in a CATV network system or optical fiber cable in a building network system.

[0002]

Prior art

Conventionally there have been internet services which use a CATV network system. These generally are called local area networks (hereinafter, LANs), and are network systems that

transmit and receive data between multiple terminal devices using an optical fiber cable and coaxial cable transmission path in a CATV network system that is deployed in a city. In recent years CATV network systems have been connected to the internet network, enabling character data, video data, audio data, and the like to be transmitted and received in addition to TV signals.

[0003]

Figure 12 shows a conventional CATV network system. The CATV network system is comprised of: a central device 22, with which a CATV station 20 is provided; an optical fiber cable 23, which is a trunk line cable connected to central device 22; an optoelectric converter 25 provided at a prescribed location on optical fiber cable 23; coaxial cables 24 extending from optoelectric converter 25; a relay device 30 provided at a prescribed location of coaxial cables 24; a branch cable 26 branching from relay device 30; a home network 40 connected to branch cable 26; and a building network 50 connected to coaxial cable 24. Furthermore, CATV station 20 has an internet interface 21 through which central device 22 is connected to an internet network 10.

[0004]

Building network 50 is comprised of an amplifier 51 that amplifies and transmits a propagated high-frequency signal, a splitter/distributor 55 that splits/distributes the signal amplified by amplifier 51, and a terminal device 52 and a TV reception device 53 connected to splitter/distributor 55. With a typical multi-unit housing complex, multiple terminal devices 52 and TV reception devices 53 are connected. Furthermore, home network 40 is comprised of a splitter/distributor 41 that splits/distributes the high-frequency signal propagated by branch cable 26, a terminal device 42 connected to splitter/distributor 41, and a TV reception device 43.

[0005]

Terminal devices 52 and 42 of the network systems are [respectively] equipped with a cable modem 54 and 44 which modulate/demodulate the high-frequency signal to an Ethernet baseband signal, or an Ethernet baseband signal to a high-frequency signal. Furthermore, terminal devices 52 and 42 are, for example, compute devices.

[0006]

The transmission method used by this CATV network system is a broadband method whereby a high-frequency signal (RF signal) is frequency-multiplexed. This is because amplifier 51 exists at the entrance to multi-unit housing network 50 or relay device 30. Therefore, the 10 MHz-55 MHz band is allocated to the uplink high-frequency signal, the 70 MHz-770 MHz signal is allocated to the downlink high-frequency signal, and two-way communication occurs.

[0007]

For example, a data signal that is input from terminal device 52 is transmitted in a prescribed communication format (10BASE-T) to a twisted pair wire 56. The data signal transmitted to twisted pair wire 56 is modulated by cable modem 54 – for example, a carrier wave with a frequency of 33 MHz is modulated with an Ethernet specification – and is transmitted to central device 22 of CATV station 20. On the other hand, central device 22 receives an demodulates the 33 MHz high-frequency signal by means of a modem not shown in the figure, and transmits that request [sic; possibly, 'a request associated with that signal'] to internet network 10 through internet interface 21, for example. If there is a reply from internet network 10, that reply is transmitted to terminal device 52 by modulating a 245 MHz downlink carrier wave with the same Ethernet specification. Cable modem 54 of terminal device 52 receives that 245 MHz high-frequency signal and performs demodulation to obtain the prescribed data. Thus, with the CATV network system data is transmitted and received between any of the terminal devices or the central device.

[0008]

Problem to be solved by the invention

However, the typical speed for data communication with a CATV [system] using the aforementioned cable modems is only up to 10 Mbps for the uplink, and when image data or the like is transmitted it cannot always be transmitted at high speed. Furthermore, there is a problem in that when many terminal devices are connected to the cable modems the throughput is reduced, and the processing speed decreases.

[0009]

The present invention is for the purpose of solving the aforementioned problems, the objective being to provide a high-speed LAN capable of receiving TV signals and capable of high-speed data communication between various devices by using optical fiber cable deployed in a city or in each office. In addition, [the objective is] to reduce the cost of the use thereof.

[0010]

Means to solve the problem and effect of operation

To solve the aforementioned problems, the transmission method using an optical fiber cable and recorded in Claim 1 is a transmission method for a network system for which an optical fiber cable or an optical fiber cable and a coaxial cable connected to that optical fiber cable are the transmission path, [the transmission method] being characterized in that a carrier

wave of a prescribed frequency higher than an existing band in use is modulated with Ethernet specification data and is frequency-multiplexed together with the existing band in use, and an optical signal that has been intensity-modulated by means of said frequency-multiplexed signal is transmitted to the aforementioned optical fiber cable, data communication being performed between terminal devices connected to the aforementioned optical fiber and/or the aforementioned coaxial cable or [being performed] with a terminal device and a central device.

[0011]

With the present method a carrier wave is modulated and frequency-multiplexed with Ethernet specification data, and light is intensity-modulated with that frequency-multiplexed signal to produce an optical signal, and that optical signal is transmitted in the optical fiber cable. A network system using optical fiber cable and coaxial cable as the transmission path is called an HFC (Hybrid Fiber and Coaxial) network system, and the upper limit frequency thereof is, for example, 770 MHz. With the present method the transmission path is optical fiber cable only or is optical fiber cable and coaxial cable, with the coaxial cable being used only for short-distance transmission that is capable of being transmitted at a band of 770 MHz or higher. Accordingly, that upper limit can be a higher-than-conventional band; for example, it can be several GHz. Furthermore, if only optical fiber cable is used the band can be even higher. In other words, by means of the present method data communication at a band exceeding the limit of an HFC network system is possible. Accordingly, the number of channels at the high band can be increased; in other words, a high-speed LAN with decreased idle time and excellent throughput can be formed.

[0012]

In addition, when data communication is performed with a carrier wave of a prescribed frequency higher than an existing band in use, the frequency band lower than the prescribed frequency can be used for other media. For example, with a CATV network system using optical fiber cable the 70 MHz-770 MHz band is allocated to the downlink signal (TV signal). Accordingly, if the carrier wave frequency higher than the prescribed [frequency] is set to higher than 770 MHz a CATV network system can be formed. In other words, a CATV network system and a high-speed communication network system can be formed using the same optical fiber cable. Accordingly, the transmission method will be extremely convenient.

[0013]

Furthermore, by means of the transmission method using an optical fiber cable and recorded in Claim 2 is characterized in that [sic] the data communication is performed by

providing that network system with a line concentration device that distributes/combines the Ethernet specification data signal, and a modem that modulates/demodulates the prescribed frequency carrier wave with that Ethernet specification data signal. The processing speed can be higher with the aforementioned line concentration device than with the cable modem of a conventional system. For example, with a cable modem the uplink signal is approximately 10 Mbps and the downlink signal is approximately 30 Mbps, but with a line concentration device approximately 100 Mbps is possible. Thus, a LAN that is capable of even higher-speed communication can be implemented.

[0014]

Furthermore, the transmission method using an optical fiber cable and recorded in Claim 3 is characterized in that the modulation by that modem is any one of amplitude modulation, frequency modulation, or phase modulation. With the aforementioned method the carrier wave frequency can be selected freely, so the number of channels can easily be increased. Accordingly, the transmission method is one for which the number of channels can easily be increased. Furthermore, an amplitude-modulate signal can easily be demodulated with a rectification circuit and a low-pass filter circuit, for example. Accordingly, the transmission method is low cost. Furthermore, a frequency-modulated or phase-modulated signal is not easily affected by random noise. Accordingly, a high-precision, high-quality transmission method is possible. Phase modulation includes PSK, QAM and the like modulation.

[0015]

Furthermore, the transmission method using an optical fiber cable and described in Claim 4 is characterized in that the data communication is performed by a multiplexing method [sic] that uses the open time for a channel for the purpose of performing that data communication. Thus, a prescribed channel can be used effectively with no waste. Accordingly, the transmission method will be cost-efficient.

[0016]

Furthermore, the relay device recorded in Claim 5 is characterized in that it is equipped with an optical transmitter-receiver that transmits and receives an optical signal, a modem that modulates/demodulates the data signal, and a line concentration device that combines/distributes that data signal. When reception occurs, the optical transmitter-receiver with which the line concentration device is provided converts the optical signal from the optical fiber cable to an electrical signal which is then transmitted to the modem. The modem modulates that signal, generating the aforementioned Ethernet specification data signal, which is transmitted to the

next-stage line concentration device. The line concentration device is a switching hub, for example, which transmits that data signal to a terminal device on a suitable path. Thus, terminal devices connected to the relay device obtain data.

[0017]

When a transmission from a terminal device occurs, the path is reversed. In other words, the line concentration device of the relay device transmits the aforementioned Ethernet specification data signal from the terminal device to the modem, and the modem modulates a carrier wave of a prescribed frequency and transmits [the signal] to the optical fiber cable. Thus, terminal devices are able to transmit and receive data directly with the Ethernet specification via the relay device. In other words, the relay device makes the aforementioned high-speed LAN possible.

[0018]

Furthermore, the network system using an optical fiber cable and described in Claim 6 is characterized in that the optical fiber cable is connected to a CATV station, and a TV signal and the aforementioned data signal are multiplexed in the downlink signal thereof. Thus, TV signals from a CATV station can be received in addition to data signals. Accordingly, the network system will be extremely convenient. Conversely, this means that an inexpensive and high-speed LAN can be formed using an already-installed CATV network system. Accordingly, the network system will be capable of high-speed communication over a wide range as well as being inexpensive and extremely convenient.

[0019]

Furthermore, the relay device described in Claim 7 is characterized in that in addition to an optical transmitter-receiver and a modem and a line concentration device, it is equipped with a distributor that distributes a TV signal. By providing this relay device both data communication and reception of a TV signal are enabled. In other words, the relay device becomes one that enables the network system described in Claim 6.

[0020]

Furthermore, the network system described in Claim 8 is characterized in that it is a building network wherein optical fiber cables are laid in a building, and in that a terrestrial broadcast and/or satellite broadcast TV signal is frequency-multiplexed and transmitted on that optical fiber cable from a broadcast reception device provided on said network. The aforementioned broadcast reception device is a device that receives terrestrial broadcasts and

satellite broadcasts. Thus, terrestrial broadcast and/or satellite broadcast TV signals can be received in addition to high-speed LAN [signals]. Therefore, the network system will be even more convenient.

[0021]

Furthermore, the network system described in Claim 9 is characterized in that it is equipped with a line connection device comprised of an optical transmitter-receiver, a modem, a line concentration device, and a distributor, and in that it is connected to a CATV network system by means of that line connection device. The optical transmitter-receiver and modem and line concentration device of the line connection device transmit data signals bidirectionally, as described above. Thus, the aforementioned central high-speed LAN is connected to an external CATV station network; in other words, a WAN is formed. Furthermore, the optical transmitter-receiver and distributor of the line connection device transmit CATV network system TV signals to the building network system. Thus, terminal devices of the building network are capable of receiving TV signals transmitted from a CATV station in addition to terrestrial broadcast and/or satellite broadcast TV signals. Therefore, the network system will be even more convenient.

[0022]

Furthermore, the network system described in Claim 10 is characterized in that the line connection device is connected to the building network with an optical coupler. The optical coupler does not require electricity. Therefore, the building network and the CATV network system can be connected inexpensively.

[0023]

Embodiments of the invention

In the following, embodiments of the present invention will be explained with reference to the figures. However, the present invention is not limited to the following application examples.

First Application Example

The transmission method of the present invention that uses an optical fiber cable is a transmission method which enables the construction of a new, high-speed data communication network in an existing network system for other media. Figure 1 shows a network system for other media and a high-speed communication network system that uses the transmission method of the present invention. The network system for other media is a system whereby video information, audio/music information, and the like from an other-media station 100 are

transmitted to the reception device of an other-media network 105, with optical fiber cable 110 and coaxial cable 120 being used in the transmission path.

[0024]

The frequency band for the existing other-media network system is divided into two bands: one is an uplink band of several tens of MHz (for example, 10-55 MHz), and one is a downlink band to the terminal devices, of several hundred MHz (for example, 70-770 MHz). In particular, 770 MHz generally is the upper limit frequency capable of long-distance transmission with the performance required for a CATV system. This upper limit frequency is based on the limits of coaxial cable. The present application example is a transmission method for which coaxial cable is not used with the aforementioned network system and only optical fiber cable is used, or for which coaxial cable is used only in the lines leading to the customer's home, for example, and the length [of said coaxial cable] is minimized. With a configuration of this type, transmission that exceeds the upper limit for coaxial cable is possible. In other words, when divided frequency bands are considered, for example, 900 MHz – several GHz can be used. In other words, the present method enables a further increase in the number of channels at the high band and improves throughput. In the following, the other band (for example, 900 MHz – several GHz) that exceeds the existing downlink frequency band (70-770 MHz) will be called the downlink high-group data band, and the modulated high-frequency signal of a data signal within that band will be called a downlink high-group data signal. Furthermore, the uplink band is open above 55 MHz, so when divided frequency bands are considered, a band of 70 MHz-several GHz, for example, can be used. In the following, the other band (for example, the 70 MHz-several GHz band) that exceeds the existing uplink frequency band (10 MHz-55 MHz) will be called the uplink high-group data band, and the modulated high-frequency data signal within that band will be called an uplink high-group data signal.

[0025]

There are two optical fiber cables 110, [one] for downlink use and [one] for uplink use, and the frequency settings for that transmission path are shown in Figure 2(a) and (b). The downlink [frequencies] are shown in (a), and the uplink [frequencies] are shown in (b); the band Ad is the existing downlink band used by the other media, and the band Au is the uplink band thereof. Furthermore, the band Dd is the downlink high-group data band used by the high-speed communication network system, and the band Du is the uplink high-group band thereof.

[0026]

The network system accommodating [sic; possibly, employing] the transmission method of the present invention, and is divided into an upstream-side system and a downstream-side system. The upstream-side system is comprised of: an optical transmitter-receiver 112a provided upstream from optical fiber cable 110; a multiplexer/demultiplexer 114a connected to optical transmitter-receiver 112a; a modem 130a connected to multiplexer/demultiplexer 114a; a hub 140a, which is a line connection device connected subsequent to modem 130a; and a central device 150 and terminal device 143a, connected to hub 140a. Modem 130a modulates a carrier wave by means of an Ethernet specification baseband data signal output from hub 140a, and outputs a downlink high-group data signal to multiplexer/demultiplexer 114a; conversely, [modem 130a] demodulates an uplink high-group data signal output from multiplexer/demultiplexer 114a, and outputs an Ethernet specification baseband data signal to hub 140a. Multiplexer/demultiplexer 114a is an aggregate device comprising filters that multiplex the band Ad signal output from other-media [station] 100 and the downlink high-group data signal of downlink high-group data band Dd output from modem 130a, and outputs [the multiplex result] to optical transmitter-receiver 112a; and that, conversely, separates the band Au signal from the uplink signal output from optical transmitter-receiver 112a, outputting it to other-media [station] 100, and separates the uplink high-group data signal of the uplink high-group data band Du, outputting it to modem 130a.

[0027]

The downstream system is comprised of: an optical transmitter-receiver 112b connected to optical fiber cable 110; a filter 113 connected to optical transmitter-receiver 112a; a modem 130b connected subsequent to filter 113; a hub 140b, which is a line connection device connected subsequent to modem 130b; and a terminal device 143 connected to hub 140b. Filter 113 separates the downlink high-group data signal of the downlink high-group data band Dd from the downlink signal output by optical transmitter-receiver 112b, outputting it to modem 130b; conversely, [filter 113] outputs to transmitter-receiver 112b the uplink high-group data signal output from modem 130b.

[0028]

Next, the function of each component will be explained according to the flow of the signals. For example, a case wherein communication occurs with terminal devices 143a, b will be considered. For a transmission from terminal device 143b, which is a computer device, first [a signal] is output to twisted pair wire 144b in a prescribed communication format (10BASE-TX). As for the Ethernet specification data signal transmitted to twisted pair wire 144, a carrier wave

of for example 70 Mhz or higher is modulated by modem 130b, and [this signal] – as the uplink high-group data band Du signal – is multiplexed with the uplink band Au output from other-media network 105, and is transmitted to optical fiber cable 110 with [sic; as] an optical signal via filter 113 and optical transmitter-receiver 112b. With the other-media network system 55 MHz and higher is unused, so it is possible to frequency-multiplex the uplink high-group data band Du.

[0029]

The optical signal transmitted to optical fiber cable 110 is received by upstream-side optical transmitter 112a and sent to multiplexer/demultiplexer 114a. Multiplexer/demultiplexer 114a extracts the uplink high-group data signal of the uplink high-group data band Du, transmitting it to modem 130a. Modem 130a demodulates the uplink high-group data signal to the original Ethernet specification data signal. Then, the data is transmitted to the destination terminal by means of hub 140a. Conversely, data from terminal device 143a it output to modem 130a via hub 140a. Based on the data, modem 130a modulates for example a 900 MHz carrier wave, outputting [the result] as a downlink high-group data signal to multiplexer/demultiplexer 114a. Multiplexer/demultiplexer 114a frequency-multiplexes the band-frequency Ad used by other-media [station] 100 and downlink high-group data band Dd of modem 130a. Then, the downlink high-group data signal passes through optical fiber cable 110 and optical transmitter-receiver 112b, is separated by filter 113, and is demodulated to a baseband data signal by means of modem 130b. This data is transmitted to terminal device 143b via hub 140b. Thus, downlink data is transmitted with a carrier wave of 900 MHz or higher, which exceeds the upper limit frequency of the band used by the other media. With other-media network 105 which also uses a long-distance coaxial cable 120, the 770 MHz and higher frequency band is not used for the downlink band, thus it is possible to frequency-multiplex the downlink high-group data band Dd.

[0030]

Thus, with the present application example an optical fiber cable is shared with the other-media network system, and high-speed communication is performed using a frequency band that the other media cannot use or are not using. Therefore, there is no need to install new optical fiber cable for use in high-speed communication. Accordingly, the result is a transmission method as well as a system thereof which implement high-speed communication inexpensively and very conveniently. Furthermore, the present application example uses a hub that is a line connection device. By using this hub and a modem it is possible to increase the processing speed as compared to a conventional system using a cable modem. For example, with a cable modem the uplink signal is approximately 10 Mbps and the downlink signal is approximately 30 Mbps,

but with a line concentration device approximately 100 Mbps is possible. Thus, a LAN that is capable of even higher-speed communication can be constructed.

[0031]

Second Application Example

The present application example is is characterized in that the transmission method of the present invention is applied to the optical fiber cable of a CATV network system. In addition, it is characterized in that a network system that enables high-speed data communication is formed without any influence on the CATV network system. A CATV network system is a system that uses optical fiber cable and coaxial cable in the transmission path, and as described above, the frequency band thereof is divided into two bands: one is the 10-55 MHz band Au of the uplink signal, as shown in Figure 2(c), and one is the 70-770 MHz band Ad of the downlink signal, as shown in Figure 2(a). In the following, the band Au will be called the uplink low-group band or simply the low-group band, and the band Ad will be called the downlink high-group band or simply the high-group band, as [they are when] used with a CATV network system. The TV signals for each channel are transmitted in the downlink high-group band Ad. In this case as well the upper limit frequency thereof is 770 MHz, based on the requirements of the CATV system. The present application example is one whereby a TV signal and a data signal are integrated at a relay device, to be described later, and are transmitted with optical fiber cable and coaxial cable incoming [or: 'lead-in'] lines. By means of a configuration of this type, high-speed data communication that exceeds the upper limit for coaxial cable is possible by means of frequency-multiplexing.

[0032]

Figure 3 illustrates a network system to which the transmission method of the present invention is applied. This system is comprised of a CATV network system and a high-speed data communication system which share a transmission path. The CATV network system is comprised of a CATV station 200, band filters 203, 204, 209, 210, a transmission path system 220, an integration device 280 that integrates a TV signal and a data signal, coaxial cable 231, a multiplexer/demultiplexer 232 that multiplexes/demultiplexes the TV signal and the data signal, and a TV reception device 233.

[0033]

Furthermore, the high-speed data communication network system is comprised of a central device 250, hubs 255, 275, modems 260, 270, band filters 203, 204, 209, 210, transmission path system 220, integration device 280, coaxial cable 231,

multiplexer/demultiplexer 232, and a terminal device 234. In transmission system 220 the system for downlink signal use is comprised of an optical fiber cable 201 and an optical transmitter 205 and optical receiver 207 which respectively transmit and receive signals of a band wherein downlink high-group band Ad and downlink high-group data band Dd shown in Figure 2(a) have been multiplexed. Furthermore, in transmission system 220 the system for uplink signal use is comprised of an optical fiber cable 202 and an optical transmitter 208 and optical receiver 206 which respectively transmit and receive signals of a band wherein uplink low-group band Au and uplink high-group data band Du shown in Figure 2(c) have been frequency multiplexed. Optical transmitter 205 and optical receiver 206 [sic; 207] and optical transmitter 208 and optical receiver 206 respectively form optical transmitter-receivers. Unlike the first application example, with the present application example, the downlink high-group data band Dd and the uplink high-group data band Du both use the same frequency band of 900 MHz to several GHz. Thus, many filters can be shared.

[0034]

Optical receiver 207, optical transmitter 208, filters 209, 210, modem 270, hub 275, and integration device 280 form a relay device (node) that relays data signals and TV signals. The network system of the present application example is one for which multiple relay devices of this type are provided in transmission path 220.

[0035]

Next, the function of each component will be explained according to the flow of the signals. For example, a case wherein a TV signal is transmitted from CATV station 200 and wherein central device 250 and terminal device 234 perform data communication will be considered. The data signal from central device 250 is transmitted with a prescribed communication format (10BASE-TX), passes through twisted pair wire 242 an hub 255, and enters modem 260. Modem 260 modulates a 1 GHz carrier wave, for example, with the Ethernet specification data signal, producing the downlink high-group data signal of downlink high-group data band Dd. This downlink high-group data signal is transmitted to band filter 203 and frequency-multiplexed with the TV signal transmitted from CATV station 200, and [the multiplex result] is transmitted to optical fiber cable 201. With a CATV system in Japan the frequency band that generally is used for television signals is 770 MHz or lower, so frequency-multiplexing of the downlink high-group data band Dd is possible.

[0036]

The optical signal (the TV signal and the downlink high-group data signal) transmitted to optical fiber cable 201 is converted to an electrical signal at optical receiver 207. Then, the TV signal and the downlink high-group data signal are again separated into their respective paths at filter 209. The separated downlink high-group data signal is demodulated to a baseband Ethernet specification data signal at modem 270 and passes through hub 275, entering integration device 280, while the TV signal directly enters integration device 280 from band filter 209.

[0037]

Figure 4 illustrates integration device 280, which integrates the TV signal and the data signal. Integration device 280 has a distributor 281 that distributes the TV signal of the downlink high-group band Ad, and a multiplexer 282 that multiplexes the signal (for example, the control signal) of the CATV system's uplink low-group band Au. In the following, the multiplying band for the downlink high-group band Ad and the uplink low-group band Au will be called the CATV band. Integration device 280 also has a band filter 283, which multiplexes/demultiplexes the TV signal and the control signal in the CATV band, and a modulation/demodulation device 285, which performs modulation/demodulation between the baseband data signal and the signal of the band (hereinafter, the data band) on coaxial cable 231. Filter 283 is demultiplexer (directional filter) which separates the downlink high-group band and the uplink low-group band for the existing CATV network system. The arrangement of the frequency bands on coaxial cable 231 is as shown in Figure 2(d). In other words, the frequency bands are comprised of a CATV band, which is comprised of uplink low-group band Au and downlink high-group band Ad, and a data band, which is comprised of uplink data band Cu and downlink data band Cd. Modulation/demodulation device 285 is a device that modulates the baseband data signal to a signal of the downlink data band Cd and demodulates the signal of the uplink data band Cu to a baseband data signal. Integration device 280 also is equipped with a filter 286. Filter 286 is a demultiplexer which separates the CATV band and the data band.

[0038]

A data signal input to integration device 280 modulates a 2 GHz carrier wave, for example, at modulation/demodulation device 285, modulating [sic; producing] a downlink data band Cd signal, which is input to filter 286 and is output to coaxial cable 231. The TV signal passes though distributor 281 and band filter 283, enters band filter 286, and is transmitted to coaxial cable 231. Conversely, the TV signal and the downlink data band signal transmitted downstream by coaxial cable 231 are separated by multiplexer/demultiplexer 232, with the TV

signal being transmitted to TV reception device 233 [and] the downlink data band signal being transmitted to terminal device 234.

[0039]

Thus, the TV signals transmitted from CATV station 200 and the data signals transmitted from central device 240 are frequency-multiplexed and transmitted to optical fiber cable 201, and then are transmitted respectively to TV reception device 233 and terminal device 234. With a conventional CATV network system the 770 MHz and higher [band] in particular is unused, so by using coaxial cable 231 only for the incoming lines and using the aforementioned configuration, the number of channels in the high band can be further increased, and thus the downlink data signal can be transmitted with those channels.

[0040]

Furthermore, when a data signal and a low-group band Au signal (for example a control signal) of the CATV network system are transmitted with an uplink signal, the control signal is transmitted with the conventional 10-55 MHz band. The [transmission] path thereof is adapter device 236, multiplexer/demultiplexer 232, coaxial cable 231, integration device 280, band filter 210, transmission path system 220, band filter 204, and CATV station 200.

[0041]

On the other hand, a data signal from terminal device 234 is transmitted with a 1 GHz carrier wave, for example, using a modem 235, and thus is modulated to an uplink data band Cu signal. This modulated high-frequency data signal passes through multiplexer/demultiplexer 232, coaxial cable 231, integration device 280, hub 275, modem 270, band filter 210, transmission path system 220, band filter 204, and again through modem 260, and hub 255, and then is transmitted to central device 250.

[0042]

Thus, a data signal transmitted from terminal device 234 and a control signal transmitted from adaptor device 235 of TV reception device 233 are respectively transmitted upstream with frequency-multiplexing. With a conventional CATV network system the 770 MHz and higher [band] in particular is unused, so by using coaxial cable only for the incoming lines and using the aforementioned configuration, the uplink data signal can be transmitted with many channels. Even if coaxial cable is used for the incoming lines with the above [configuration], the uplink data signal and the downlink data signal can be transmitted with frequency-multiplexing, and an efficient and high-speed LAN can be formed.

[0043]

Third Application Example

Figure 5 illustrates a third application example of the transmission method of the present invention that uses an optical fiber cable. The figure is a structural diagram. Figure 6 illiustrates the structure of the relay device 400, and Figure 7 shows the structure of the line connection device. The present application example is one for which a high-speed LAN is formed using the optical fiber cable of an existing building network that transmits CS broadcasts and BS broadcasts.

[0044]

The network system of the present application example is comprised of a BS receiver 302, a CS receiver 304, a mixer 306, an optical transmitter 308, an optical distributor 310, an optical fiber cable 311, an optical coupler 312, a relay device 400, a TV reception device 316, and a terminal device 318.

[0045]

Satellite TV signals received by BS receiver 302 and CS receiver 304 are mixed by mixer 306 and [the resulting signal is] converted to light by the next-stage optical transmitter 308. Next, [an optical signal] is transmitted to each transmission path (optical fiber cable 311) by next-stage optical distributor 310. The transmitted optical signal is input to the relay device 400 of each customer's home by means of the optical coupler 312 provided on optical fiber cable 311. Furthermore, a portion [of the signal] passes through optoelectric converter 313 and coaxial cable 231 and is transmitted directly to the customer's TV reception device 316.

[0046]

Figure 6 illustrates relay device 400. Relay device 400 is comprised of an optical receiver 402, an optical transmitter 404, band filters 406, 408, 410, a modem 412, an amplifier 414, a distributor 418, and a hub 416. The satellite TV signal input to optical receiver 402 is converted to an electrical signal and is input to band filter 406; it then passes through band filters 406 and 410 and is amplified by amplifier 414, arriving at distributor 418, whereby it is transmitted to each TV reception device 316 (Figure 5). A prescribed frequency band is used for this transmission. The prescribed frequency band can be any band other than the frequency band used by the following high-speed data communication system and the frequency band used by the CATV network system.

[0047]

In addition, high-speed data communication is possible with the aforementioned configuration. With a LAN that uses optical fiber cable all of the uplink bands are open, so a method whereby the light is intensity-modulated with a baseband data signal can be used. For example, when an Ethernet specification data signal is transmitted from terminal device 318 (Figure 5), the data signal transmitted from terminal device 318 is collected in hub 416 (Figure 6) and converted to an optical signal (the baseband signal is modulated) by optical transmitter 404, and is then transmitted to optical fiber cable 311. This optical signal is input to line connection device 500 via optical coupler 312. Line connection device 500, which is shown in Figure 7, inputs the optical signal from an optical receiver 503, converts it to an electrical signal (baseband data signal), and inputs it to a hub 515.

[0048]

The baseband data signal that is input to hub 515 it output to the internet via a router 546. Conversely, a baseband signal from the internet is input to hub 514 via router 546. Then, it is converted to a downlink high-group data signal of downlink high-group data band Dd by a modulator 544, passes through a bandpass filter 542 and enters an optical transmitter 502, where it is converted to an optical signal which is then output to optical fiber cable 311. This downlink high-group data signal passes from optical fiber cable 311 through optical receiver 402 (Figure 6) and band filter 406, and the downlink high-group data signal of downlink high-group data band Dd is demodulated by modem 412, obtaining the baseband data signal. Thus, data signals transmitted from other terminal devices are demodulated. This demodulated signal is transmitted to the destination terminal device 318 by hub 416. Thus, internet communication is possible. The present method transmits the signal with a high-frequency carrier wave of a frequency other than that used for the satellite TV transmission. Therefore, data communication can be performed without influencing the TV signal. Furthermore, the number of channels can be increased for this high-frequency band. The result is a high-speed LAN capable of even faster data communication. Furthermore, when data communication occurs between terminal devices in a building network, uplink data signals received by hub 515 can be distributed (returned) by hub 515, thus transmitting [said signals] to other terminal devices with the same route as that of downlink data signals from the internet, as described above.

[0049]

<u>Fourth Application Example</u>

Figure 8 illustrates a fourth application example wherein the transmission method of the present invention is used. The figure is a system diagram. The present application example is

equipped with the line connection device connected to a CATV network system in the third application example, and the high-speed LAN of the third application example is connected to an existing CATV network system installed in a city. In the figure, identical components are denoted with the same numbers.

[0050]

Line connection device 500 is arranged between an building network system and a CATV network system via optical couplers 312b. Figure 9 shows line connection device 500. Line connection device 500 is comprised of: an optical transmitter 502 connected to the optical fiber [cable] of an building network; an optical receiver 503; band filters 506, 508; distributors 509 and 510, which distribute TV signals; modem 512 that modulate/demodulate data signals; a hub 515, which is a line concentration device to which multiple modems 512 are connected downstream; a modem 517 connected upstream from hub 515; band filters 520, 522; an optical receiver 524 connected to the CATV network system side; and an optical transmitter 526. In this case as well, one optical transmitter-receiver is formed by optical transmitter 502 and optical receiver 503, and [another is formed] by optical receiver 524 and optical transmitter 526.

[0051]

For example, an uplink high-group data signal transmitted from terminal device 318 (Figure 8) passes through relay device 400, optical coupler 312a, optical fiber cable 311, and optical coupler 312b, and is input to line connection device 500. The uplink high-group data signal that is input to the line connection device 500 shown in Figure 9 is received by optical receiver 503, converted to an electrical signal, and is input to band filter 508. This signal is separated by the high-pass filter of band filter (HPF) 508 and is input to modem 512.

[0052]

At modem 512 that uplink high-group data signal is demodulated to an Ethernet specification data signal. Next, it is output to hub 515; hub 515 reads the address and the like of that data and transmits [the data] to the relevant path – for example, the CATV network system. The transmission [process] is [as follows:] at modem 517 the carrier wave of the uplink high-group data band is modulated, obtaining an uplink high-group data band Dd signal, which passes through band filter 522 and optical transmitter 526 and is transmitted to optical fiber cable of the CATV network system. The signal transmitted to this optical fiber cable 202 follows the path shown in Figure 3, being transmitted toward central device 250. [The signal] is returned by means of hub 255 (distributed by means of a function of the hub), which is connected to this central device 250. In other words, as explained with the second application example, [the signal]

is transmitted to the terminal device side as a downlink high-group data signal. Thus data is transmitted to another terminal device on the CATV network system.

[0053]

This downlink high-group data signal is received from optical fiber cable 201 by optical receiver 524, converted to an electrical signal, and output to band filter 520. The downlink high-group data signal passes through the HPF, enters modem 517, and is demodulated. The demodulated data signal then is assigned to modem 512 on a prescribed path by mean of hub 515.

[0054]

Modem 512 again modulates [the received signal] to a downlink high-group data band Dd signal, which is transmitted to band filter 506. The transmitted downlink high-group data signal passes through the same HPF filter and is transmitted to optical transmitter 502. Then, optical transmitter 502 transmits [the signal] to optical fiber cable 311 of the building network system via optical coupler 312b (Figure 8). Thus data is transmitted from a terminal device on the CATV network system a terminal device on the building network system. The reception method is identical to that of the third application example. With the present system as well – wherein the connection to the CATV network system is by means of the line connection device – the uplink high-group data band Du and the downlink high-group data band Dd, which transmit the data signal on the optical fiber transmission path, are bands other than the frequency band used for the TV signal. Therefore, a WAN enabling high-speed data communication between a building network and a CATV network system can be constructed.

[0055]

Alternative examples

In the above one application example representing the present invention was illustrated, but various other alternative examples can be considered. For example, with the first application example the uplink high-group data band Du was 70 MHz or higher and the downlink high-group data band Dd was 900 MHz or higher, but they can use the same band, as with the second application example. Furthermore, with the first application example modem 130b was directly connected to optical transmitter-receiver 112b; however, as shown in Figure 10, a demultiplexer 114b can be provided on coaxial cable 120, and a modem 130c, hub 140c, and terminal device 143c can be connected thereto. If coaxial cable 120 is used as a short line such as an incoming line, the transmission method of the first application example can be applied.

[0056]

Furthermore, with the second application example the TV signal and the data signal were integrated with integration device 280 and transmitted to the customer's terminal device 234 and reception device 233, but integration device 280 does not have to be provided. As shown in Figure 11, transmission path system 220 and TV reception device 233 can be directly connected with two coaxial cables 238, 239, and terminal device 234 can be directly connected to hub 275. With the second application example the uplink high-group data band Du was set in the 900 MHz or higher band because the TV signal band (55-770 MHz) was on coaxial cable 231, but if a configuration of this type is used the uplink high-group data band Du can be set in a wide range from 55 MHz to several GHz. Furthermore, an efficient and high-speed LAN can be formed.

Brief description of the figures

Figure 1 is a structural diagram for a network system that applies the transmission method using an optical fiber cable according to the first application example of the present invention.

Figure 2 is a diagram illustrating the arrangement of the frequencies used in the transmission method of the present invention that uses an optical fiber cable.

Figure 3 is a structural diagram of a system for which the transmission method using an optical fiber cable of the present invention is applied to a CATV network system, according to a second application example.

Figure 4 is a block diagram of the integration device according to the second application example of the present invention.

Figure 5 is a structural diagram of a system for which the transmission method that uses an optical fiber cable of the present invention is applied to a building network system, according to a third application example.

Figure 6 is a block diagram of the relay device according to the third application example.

Figure 7 is a block diagram of the line connection device according to the third application example.

Figure 8 is a structural diagram of a system for which the transmission method according to a fourth application example of the present invention is applied to a building network system and a CATV network system.

Figure 9 is a block diagram explaining the line connection device according to the fourth application example of the present invention.

Figure 10 is a structural diagram of a network system using an optical fiber cable, illustrating an example of a modification of the first application example of the present invention.

Figure 11 is a structural diagram of a network system using an optical fiber cable, illustrating an example of a modification of the second application example of the present invention.

Figure 12 is a structural diagram illustrating a conventional transmission method that uses optical fiber cable.

Explanation of symbols

110, 201	Optical fiber cable
202, 311	Optical fiber cable
112a, b	Optical transmitter-receiver
114a, b	Multiplexer/demultiplexer
120, 231	Coaxial cable
130a, b	Modem
260, 270	Modem
140a, b	Hub
255, 275	Hub
150, 250	Central device
143a, b	Terminal device
234, 318	Terminal device
200	CATV station
205, 208	Optical transmitter
206, 207	Optical receiver
233, 316	TV reception device
280	Integration device
312	Optical coupler
400	Relay device
500	Line connection device

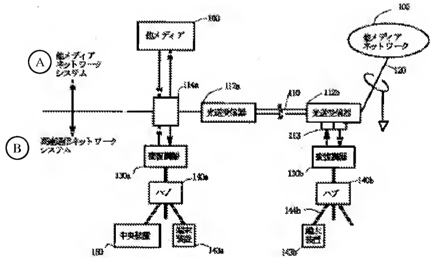


Figure 1

Key: A Other-media network system
B High-speed communication network system
100 Other media
105 Other-media network
112a, 112b Optical transmitter-receiver
130a, 130b Modem
140a, 140b Hub
143a, 143b Terminal device
150 Central device

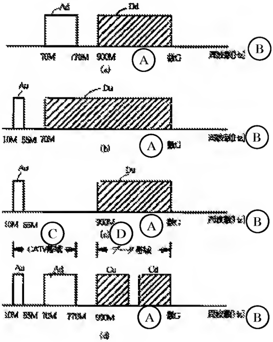


Figure 2

Key:
- A Several G
- B Frequency (Hz)
- C Band
- D Data band

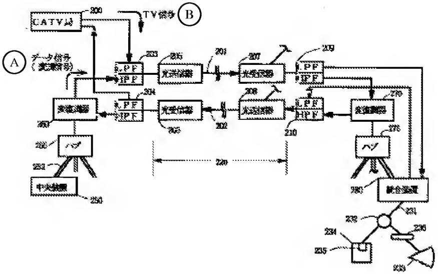


Figure 3

Key:
- A Data signal (modulated signal)
- B TV signal
- 200 CATV station
- 205, 208 Optical transmitter
- 206, 207 Optical receiver
- 250 Central device
- 255, 275 Hub
- 270 Modem
- 280 Integration device

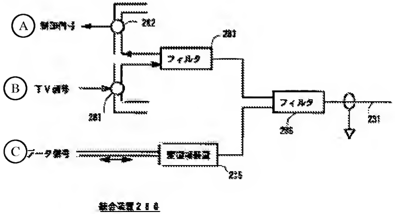


Figure 4

Key: A Control signal
B TV signal
C Data signal
280 Integration device
283 Filter
285 Modem
286 Filter

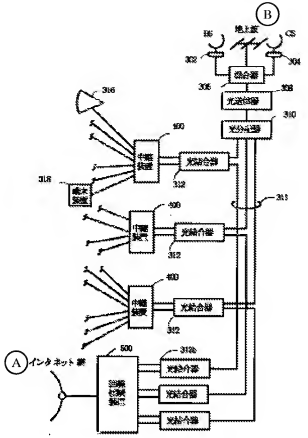


Figure 5

Key: A Internet network
B Terrestrial wave
306 Mixer
308 Optical transmitter
310 Optical distributor
312 Optical coupler
318 Terminal device
400 Relay device
500 Line connection device

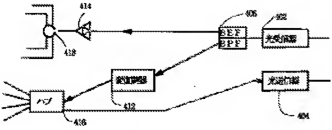


Figure 6

Key: 402 Optical receiver
404 Optical transmitter
412 Modem
416 Hub

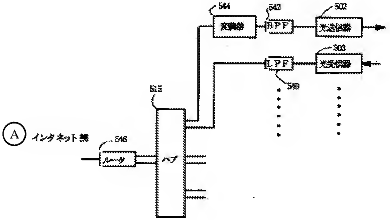


Figure 7

Key: A Internet network
502 Optical transmitter
503 Optical receiver
515 Hub
544 Modem
546 Router

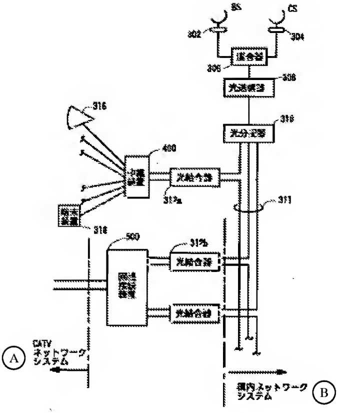


Figure 8

Key:

A	CATV network system
B	Building network system
306	Mixer
308	Optical transmitter
310	Optical distributor
312a, 312b	Optical coupler
318	Terminal device
400	Relay device
500	Line connection device

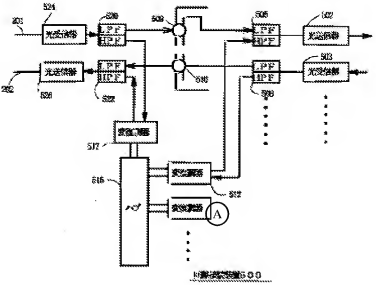


Figure 9

Key:
- A — Modem
- 500 — Line connection device
- 502, 526 — Optical transmitter
- 503, 524 — Optical receiver
- 512, 517 — Modem
- 515 — Hub

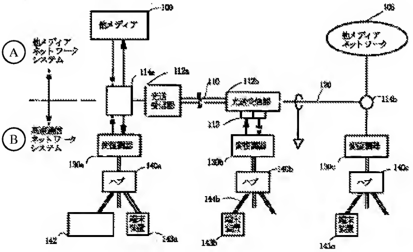


Figure 10

Key:
- A — Other-media network system
- B — High-speed communication network system

100 Other media
105 Other-media network
112a, 112b Optical transmitter-receiver
130a, 130b, 130c Modem
140a, 140b, 140c Hub
143a, 143b, 143c Terminal device

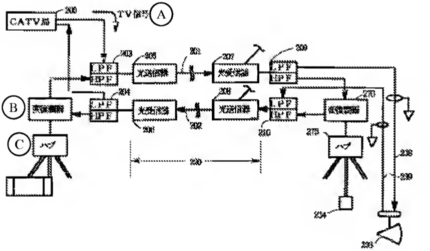


Figure 11

Key: A TV signal
B Modem
C Hub
205, 208 Optical transmitter
206, 207 Optical receiver
270 Modem
275 Hub

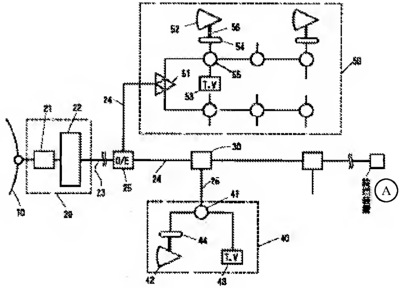


Figure 12

Key: A Terminal device